

at Brigham City, and the least, "trace," at Giles and Mammoth. Upon the whole, the weather conditions were exceptionally fine for farm work, but very detrimental to stock interests.—*J. H. Smith.*

*Virginia.*—The mean temperature was 36.9°, or 3.1° below normal; the highest was 86°, at Stanleyton on the 8th, and the lowest, 2°, at Dale Enterprise. The average precipitation was 1.02, or 2.59 below normal; the greatest monthly amount, 4.04, occurred at Hampton, and the least, "trace," at several stations.—*E. A. Evans.*

*Washington.*—The mean temperature was 40.0°, or 2.3° above normal; the highest was 65°, at Sedro on the 8th and 9th and Kennewick on the 9th, and the lowest, 5°, at Loomis on the 1st. The average precipitation was 7.97, or 1.37 above normal; the greatest monthly amount, 26.26, occurred at Clearwater, and the least, 1.14, at Moxee.—*G. N. Salisbury.*

*West Virginia.*—The mean temperature was 35.0°, or about normal; the highest was 67°, at Old Fields on the 13th, and the lowest, 2° below zero, at Marlinton on the 25th. The average precipitation was 1.68,

or 1.50 below normal; the greatest monthly amount, 2.88, occurred at Beverly, and the least, 0.57, at Romney. Very little snow fell in the Ohio Valley and its larger tributaries. In the mountains the total depth at some stations ranged from 4 to 8 inches. It was generally moist in character and soon disappeared. The weather on the whole was beneficial to the winter wheat, and at the close of the month this crop was in good condition and promising.—*H. L. Ball.*

*Wisconsin.*—The mean temperature was 28.6°, or 2.0° above normal; the highest was 62°, at Delavan on the 29th, and the lowest, 20° below zero, at Spooner on the 1st. The average precipitation was 0.84; the greatest monthly amount, 2.44, occurred at Hayward, and the least, 0.05, at Chilton.—*W. M. Wilson.*

*Wyoming.*—The mean temperature was 32.1°; the highest was 70°, at Fort Laramie on the 11th, and the lowest, 13° below zero, at Fort Washakie. The average precipitation was 0.10; the greatest monthly amount, 0.46, occurred at Fort Yellowstone, while none fell at Fort Laramie, Fort Washakie, and Wise.—*M. G. Renoe.*

## RIVER AND FLOOD SERVICE.

By PARK MORRILL, Forecast Official, in charge of River and Flood Service.

The extreme and average stages of water in the rivers for the current month are given in Table VIII. In no case have the rivers reached dangerous heights. At the close of the month navigation on the upper Mississippi and the Missouri was practically suspended. The latter river was frozen north of Sioux City. The Ohio and lower Mississippi were navigable throughout the month. The rivers of the Atlantic Coast and the South have been at low stages.

The following résumé of river stages and conditions of navigation in the various streams is compiled from reports by the following officials of the Weather Bureau at various river stations and section centers:

A. F. Sims, Observer, Albany, N. Y.; E. R. Demain, Observer, Harrisburg, Pa.; E. A. Evans, Local Forecast Official, Richmond, Va.; C. F. von Herrmann, Observer, Raleigh, N. C.; L. N. Jesunofsky, Local Forecast Official, Charleston, S. C.; David Fisher, Observer, Augusta, Ga.; J. B. Marbury, Local Forecast Official, Atlanta, Ga.; W. M. Dudley, Observer, Mobile, Ala.; F. P. Chaffee, Local Forecast Official, Montgomery, Ala.; S. S. Bassler, Local Forecast Official, Cincinnati, Ohio; Frank Ridgway, Local Forecast Official, Pittsburgh, Pa.; H. L. Ball, Observer, Parkersburg, W. Va.; L. M. Pindell, Observer, Chattanooga, Tenn.; F. J. Walz, Local Forecast Official, Davenport, Iowa; H. C. Frankfield, Local Forecast Official, St. Louis, Mo.; S. C. Emery, Observer, Memphis, Tenn.; R. J. Hyatt, Local Forecast Official, Vicksburg, Miss.; R. E. Kerkam, Local Forecast Official, New Orleans, La.; L. A. Welsh, Local Forecast Official, Omaha, Nebr.; Patrick Connor, Local Forecast Official, Kansas City, Mo.; F. H. Clarke, Local Forecast Official, Little Rock, Ark.; W. H. Hammon, Forecast Official, San Francisco, Cal.

*Hudson River.*—On the 4th much anchor ice formed in the river, but the mild conditions of the 6th caused all the ice to disappear from both river and basin. On the 16th anchor ice again appeared in the river. The prevalent northerly wind kept the water in the Hudson below the normal level and rendered navigation difficult from Van Wines Point to Troy. The People's Line sent their last boat south on the evening of the 16th. The steamer *City of Troy* left for New York City on the 17th, the last south bound boat of the season from the head of tidewater navigation. Half-inch ice covered the Albany basin on the 17th, and had thickened to 3 inches by the 19th. On the morning of the 20th the Hudson River was frozen over from Troy to Hudson, and the ice men took advantage of the situation and began the work of staking out ice claims. The high west and northwest winds filled the ice with dust particles, which will detract somewhat from what would otherwise be considered a perfect ice formation in the Albany district. At the close of the month an average of 4 inches of snow covered the Hudson and Mohawk watersheds; the ice in the Mohawk averaged 13 inches in thickness at Schenectady and that in the Hudson ranged from 7 inches at the State dam to 2 inches at Newberg.

*Susquehanna River and branches.*—Notwithstanding the fact that the precipitation over the drainage area of the Susquehanna River and its

tributaries was very light, probably less than during any December since observations began, the streams maintained about the average stages of water for the time of year. At Harrisburg the river averaged 0.4 of a foot higher than in December, 1895, although the rainfall was only about 12 per cent of the amount reported for December, 1895, being the least (only 0.40 inch) for any December since the Weather Bureau station was opened. On the West Branch and the Juniata the rainfall was heavier, averaging about 1 inch. The West Branch was reported closed at Farrandville during the entire month. It closed at Renova on the 24th and at Keating on the 25th. The Juniata was closed at Mifflin from the 3d to the 8th and from the 24th to the close of the month. The Susquehanna did not freeze over at Harrisburg, but there was ice along its banks, from the 24th to the 29th, sufficient for skating. It closed between Columbia and Wrightsville, about 60 miles below Harrisburg, on Christmas night, and on December 28 the ice was 5 to 6 inches thick, and persons were able to cross on foot. It was still closed at the end of the month, although probably not safe for crossing at that time on account of the milder weather.

*Rivers of the South Atlantic States.*—The rainfall in the valley of the James was light, and as a consequence the river remained low. There were no perceptible rises attendant upon any of the rains which fell. In the upper valley there was a steady fall of the river during the entire month, with the exception of the 7th and 29th, when slight rises occurred. The close of the month found the river in its normal condition as to purity and height for the time of year.

The rivers of North Carolina were uniformly low, though somewhat higher than during November. Slightly higher stages prevailed from the 2d to 5th, 8th to 11th, and 17th and 18th, but in no case approached the danger lines. The lowest stages were attained toward the end of the month.

The heavy rainfall in South Carolina on the 1st and 2d was mostly confined to the coast region, and in consequence there were no freshets of marked severity. The rains were followed early on the morning of the 2d at points within 50 miles of the coast by an ice storm covering everything with a coating of ice one-half inch to one and one-quarter inches thick, which prostrated many trees and caused much damage to the telegraph poles and wires. Snowfall measuring 3 to 8 inches occurred over the central portion of the State on the 2d. It melted slowly during the 3d to 6th, and had but little effect upon the streams in that section. Thin and running ice was observed in the Wateree at Camden and in the Great Pee Dee at Cheraw on the 3d to 5th and the 24th to 26th.

The Great Pee Dee was navigable up to Cheraw until the 23d. The Congaree was at a low stage during the last half of the month. Many cotton factories located on the Saluda and Broad rivers were running from the 1st to the 16th; after that date they were shut down again on account of the lack of water. The Waccamaw remained at a navigable stage from Winyah Bay to Waccamaw during the entire month. Navigation was uninterrupted on the Santee and Wateree between St. Stephens and Camden during the month. More merchandise was shipped at Charleston and Georgetown over the various streams than for many months past.

Two rises occurred in the Savannah River during the month, the first culminating on the 3d and the other on the 16th. No better conditions could be desired for navigation than have prevailed, the boats making regular trips with fairly good cargoes, cotton forming the chief commodity now in transportation.

Other Georgia rivers, low at the beginning of the month, continued so to its end. There were no sudden rises and the changes were but slight from day to day.

*Mobile River and branches.*—The Mobile River and its tributaries have,

with the exception of the first four days of the month, continued unusually low as very little rain has fallen; the boats could go no farther upstream than Demopolis on the Tombigbee the first three weeks of the month, and no higher than Gays Landing during the closing week of the month. The Alabama River was navigable during the first half of the month, but scarcely so during the latter half.

**Ohio River and branches.**—During the entire year just closed the Ohio has been navigable, and the oldest river men say that they can not remember a year comparable with 1896 for long periods of good stages and freedom from interruption of navigation.

There was a coal-boat stage at Pittsburg during the first two days of December and again from the 10th to the 14th. Smaller packets have been running during the entire month, but there has been scarcely enough water for the large packets since the 26th. Large quantities of ice were running in the Alleghany River on the 4th, 22d, 23d, and 24th.

The month's rainfall, was below the normal. The rainfall of the 8th and 9th occurred chiefly in the upper Ohio Valley and the West Virginia watersheds. Rains during the latter part of November had swelled the Monongahela, and at the opening of December the Ohio below Pittsburg showed an ebbing flood of moderate height. At the same time the Great and Little Kanawhas had good water stages. The Ohio and its northern tributaries began rising on the 9th. During the latter half of the month the rivers fell slowly but not sufficiently low to interfere with navigation except by the largest boats. The river men state that, as regards the stages of water, December was an unusually good month, although business was dull. From the 25th to the 30th the Ohio was running pretty heavily with ice, which caused a temporary tie up on some of the packet lines.

The highest water in the Tennessee occurred at the beginning of the month. The stage at Chattanooga was the highest recorded in the past ten years. There were eighteen more days of navigable water than in 1895. The river was open to navigation by small boats the entire month, but all large boats were tied up on the 28th. The river was practically free from drift during the month, and its general condition has been favorable for those engaged in river traffic and considerable business was done.

**Mississippi River and minor branches.**—Navigation above Davenport was practically closed during the entire month, and no boats were running with the exception of a few ferryboats. The river was frozen, however, for only a part of the month. It remained open below Dubuque, though the greater part of the time there was a considerable quantity of floating ice. The ice gorge which formed just below Lake Pepin during the latter part of November, remained in the river during the greater part of the month, and with little change as far as the location and character of the gorge itself was concerned. The water, however, broke passageway under it and the stage declined at Reeds Landing after the 1st. There was a sharp rise in the river at La Crosse the first four days of the month, and at North McGregor from the 5th to the 12th; this rise reached Dubuque between the 8th and the 12th, and carried the ice out in that section.

The river from Davenport to St. Louis was low, but sufficiently high for light traffic. There was, however, little navigation above St. Louis; only a few boats carrying grain made trips from the Illinois River. On this latter river towboats were still running at the end of the month. Ice commenced running past St. Louis on the 2d. The quantity was small, and by the 5th it had disappeared. A second run occurred on the 26th and disappeared by the 29th. From the 19th to the 25th the river from Burlington, Iowa, to Hannibal, Mo., was filled with heavy ice, and on the 27th the ice in Quincy Bay attained a thickness of two inches.

From St. Louis to Cairo there has been little change in the prevailing low water, but south of Cairo there was a marked rise. At Memphis the stage of water increased rapidly from the 1st to the 10th, the increase averaging about one foot for each day, until a stage of 16.6 feet was reached on the 10th, after which it fell gradually to the end of the month, though a good depth of water was maintained at all times. Navigation was not interrupted in any way during the month, either in the Mississippi or its numerous tributaries between Cairo and Memphis, and the conditions upon the whole were unusually favorable for the river men. No ice has yet been seen in this section.

The Mississippi River and its tributaries between Memphis and Vicksburg were low, especially the tributary streams, owing to the unusually small amount of precipitation during the month of December, but they were navigable, except the upper White River, where navigation was suspended.

The Mississippi, south of Vicksburg, showed a marked rise for the season of the year between the 5th and middle of the month, affecting the stage at Vicksburg by a 12-foot rise, but decreasing to a rise of less than three feet at New Orleans. A gradual decline occurred between the 15th and 22d, amounting to about seven feet at Vicksburg, and less than two feet at New Orleans. The fluctuations after the 22d were slight.

The Red River showed mild fluctuations during the first ten days of the month, during which the highest waters occurred; thereafter there was a general and very gradual decline to stages below zero at Shreveport and Alexandria during the latter part of the month. The highest waters in the Ouachita occurred during the early part of the month,

Camden and Monroe showing 14-foot stages. There was a general and rapid decline at Camden after the 1st, and at Monroe after the 7th; the month closed with low stages for the season. Navigation was interfered with in the Red and Ouachita rivers during the greater part of the month, the Red River boats running light draft as far north as Coushatta, and no traffic worthy of mention existing on the Ouachita.

**Missouri River.**—At Omaha the river was practically frozen over until the afternoon of the 9th, when the ice broke up and ran out. Ice was running on the 5th and 6th at St. Joseph, the river becoming clear on the 7th. The river was clear southward from Sioux City at the close of the month. At Kansas City the river was clear of ice from the 8th to the 20th and 27th to 31st, inclusive; during the rest of the month there was more or less floating ice.

**Arkansas River.**—During the first fourteen days of December a fairly good boating stage prevailed in the upper river between Dardanelle and Little Rock. On December 15 a decline set in and continued to the end of the month, the water during this time being too low for navigation except by the smallest boats. The lower river, south of Little Rock, was navigable during the entire month. The low stage was very favorable for constructing the bridge at Little Rock. At the end of the month the piers were so far advanced that high water could not do damage other than to delay work. No ice has been seen during the month.

**Rivers of the Pacific Coast.**—The Sacramento River at the beginning of the month was at a stage permitting easy navigation. The river continued nearly stationary until the middle of the month, when, owing to heavy rains, there was a rapid rise. The Willamette rose steadily during the first half of the month, nearly reaching the danger line at Portland. A steady fall then set in and continued to the end of the month.

TABLE VIII.—Heights of rivers above zeros of gauges, December, 1896.

Stations.	Distance to mouth of river.	Danger-line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Mississippi River.</i>								
St. Paul, Minn.	Miles. 1,934	Feet. 12	Feet. 7.0		Feet. 1.9		Feet. 4.3	Feet. 5.1
Reeds Landing, Minn.	1,864	14	7.5			29-31		
La Crosse, Wis.	1,790	10	7.5					
North McGregor, Iowa	1,739	18	7.7	13	2.1	1	5.9	5.6
Dubuque, Iowa <sup>b</sup>	1,679	15	7.6	12	1.2	2	5.0	6.4
Leclaire, Iowa	1,589	10	4.4	14	0.0	5, 6	2.4	4.4
Davenport, Iowa	1,573	15	5.1	14	0.5	6	3.1	4.6
Keokuk, Iowa	1,443	14	5.0	18	0.4	4, 7	2.7	4.6
Hannibal, Mo.	1,382	17	5.3	17-19	1.1	9, 10	3.1	4.2
Grafton, Ill.	1,334	23	7.0	19, 20	3.4	11	5.0	3.6
St. Louis, Mo.	1,241	30	7.8	21	3.8	11	5.9	4.0
Chester, Ill.	1,170	30	4.7	22	1.8	12	3.3	2.9
Cairo, Ill.	1,073	40	24.9	7	13.2	31	18.9	11.7
Memphis, Tenn.	843	33	16.6	9, 10	5.8	1	11.2	10.8
Helena, Ark.	767	37	22.3	10	9.5	1	16.6	12.8
Arkansas City, Ark.	635	42	22.0	11, 12	10.0	2	16.5	12.0
Greenville, Miss.	595	40	18.7	12	8.0	2	13.7	10.7
Vicksburg, Miss.	474	41	19.4	13, 14	7.3	2-4	18.6	12.1
New Orleans, La.	108	13	5.8	14, 15	3.2	4	4.7	2.6
<i>Arkansas River.</i>								
Fort Smith, Ark.	345	22	7.6	1, 2	2.2	31	3.6	5.4
Dardanelle, Ark.	250		8.0	1	1.6	30, 31	3.3	6.4
Little Rock, Ark.	170	23	9.2	3	3.5	30, 31	5.3	5.7
<i>White River.</i>								
Newport, Ark.	150	21	3.6	4	6.9	31	1.9	2.7
<i>Illinois River.</i>								
Peoria, Ill.	135	14	7.5	1	5.4	28, 30, 31	6.5	2.1
<i>Missouri River.</i>								
Bismarck, N. Dak. †	1,201	14						
Pierre, S. Dak. †	1,006	14						
Sioux City, Iowa †	676	19						
Kansas City, Mo.	280	21	8.0	21	2.8	7	5.9	5.2
Boonville, Mo.	191	20	6.5	24	4.4	6, 7	5.4	2.1
Hermann, Mo.	95	21	2.3	2	-0.6	9	0.9	2.9
<i>Ohio River.</i>								
Pittsburg, Pa.	966	22	11.9	11	2.0	27, 28	5.0	9.9
Davis Island Dam, Pa.	960	25	12.1	11	3.6	27	6.6	8.5
Wheeling, W. Va.	875	36	15.9	12	4.2	28, 29	8.3	11.7
Marettta, Ohio.	795	25	16.0	12	5.0	30	9.2	11.0
Parkersburg, W. Va.	785	38	15.8	13	5.8	31	9.9	10.0
Point Pleasant, W. Va.	703	38	20.4	2	4.3	31	11.4	16.1
Catlettsburg, Ky.	651	50	27.5	1	6.0	31	15.5	21.5
Portsmouth, Ohio	612	50	28.0	1	7.6	31	16.7	20.4
Cincinnati, Ohio.	499	45	29.2	3	10.1	30	19.7	19.1
Louisville, Ky.	367	24	11.3	3	6.0	31	8.7	5.8
Evansville, Ind.	184	30	23.5	5	9.3	31	17.0	14.2
Paducah, Ky.	47	40	21.8	6	8.1	31	15.0	13.7
<i>Alleghany River.</i>								
Warren, Pa.	177	7	4.8	10	0.8	28-30	1.9	4.0
Oil City, Pa.	123	13	5.4	10	1.5	30	2.8	3.9
Parker, Pa.	73	20	6.7	11	1.2	27, 29	2.7	6.5
Freeport, Pa.	26	30	10.4	11	2.3	26-28	4.9	8.1
<i>Conemaugh River.</i>								
Johnstown, Pa.	64	7	2.5	10	0.8	29, 30	1.5	1.7
<i>Red Bank Creek.</i>								
Brookville, Pa.	35	8	3.7	9	1.0	1-8, 15-31	1.3	2.7
<i>Beaver River.</i>								
Ellwood Junction, Pa.	*10	14	3.6	10, 11	1.8	27-31	2.4	1.8
<i>Big Sandy River.</i>								
Louisa, Ky.	26	20	16.4	1	4.0	30	7.5	12.4
<i>Cumberland River.</i>								
Burnside, Ky.	434	50	17.0	1	1.1	31	3.8	15.9
Nashville, Tenn.	175	60	28.9	1	3.5	31	10.3	25.4

TABLE VIII.—Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger-line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Great Kanawha River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Charleston, W. Va.....	61	30	11.6	1	3.1	29	6.1	8.5
<i>New River.</i>								
Hinton, W. Va.....	95	14	6.3	1	1.3	27-29	2.7	5.0
<i>Licking River.</i>								
Falmouth, Ky.....	30	25	8.0	1	2.4	21-25, 29-31	3.4	5.6
<i>Miami River.</i>								
Dayton, Ohio.....	69	18	3.9	16	1.1	2	2.1	2.8
<i>Monongahela River.</i>								
Weston, W. Va.....	161	18	6.9	9	— 0.3	27-29	0.7	7.2
Fairmont, W. Va.....	119	25	8.6	10	1.1	8	2.5	7.5
Morgantown, W. Va.....	95	20	13.3	10	7.4	28-30	8.6	5.8
Greensboro, Pa.....	81	18	13.0	10	7.5	28-31	8.6	5.5
Lock No. 4, Pa.....	40	28	15.0	11	7.1	27-30	9.0	7.9
<i>Cheat River.</i>								
Rowlesburg, W. Va.....	36	14	6.0	9	2.8	28-31	3.5	3.2
<i>Youghiogheny River.</i>								
Clunefence, Pa.....	59	10	3.7	1	1.3	29	2.1	2.4
West Newton, Pa.....	15	23	4.7	10	0.5	29	1.6	4.2
<i>Tennessee River.</i>								
Knoxville, Tenn.....	614	29	10.0	1	0.9	30-31	2.1	9.1
Chattanooga, Tenn.....	430	33	13.9	3	2.5	31	5.3	11.4
Bridgeport, Ala.....	390	.....	10.9	3	1.2	31	3.6	9.7
Florence, Ala.....	220	16	8.9	5	1.3	31	3.8	7.6
Johnsonville, Tenn.....	94	21	12.4	6	3.1	29, 31	6.7	9.3
<i>Wabash River.</i>								
Terre Haute, Ind.....	165	16	5.1	20	1.7	30, 31	3.0	3.4
Mt. Carmel, Ill.....	50	15	9.1	1	3.0	31	5.3	6.1
<i>Red River.</i>								
Arthur City, Tex.....	688	27	11.0	3	2.6	28-31	4.6	8.4
Fulton, Ark.....	565	28	11.7	1	1.2	30, 31	4.0	10.5
Shreveport, La.....	449	29	4.0	5	— 1.9	1	0.6	5.9
Alexandria, La.....	139	33	4.4	10	— 1.2	31	1.6	5.6
<i>Atchafalaya River.</i>								
Melville, La.....	100*	31	18.7	16	10.5	1	14.6	8.2

TABLE VIII.—Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger-line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Onachita River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Camden, Ark.....	340	39	15.0	1	4.1	31	6.3	10.9
Monroe, La.....	100	40	15.7	5	2.9	30, 31	7.9	12.8
<i>Yazoo River.</i>								
Yazoo City, Miss.....	80	25	3.6	9-11	— 1.8	30, 31	2.0	5.4
<i>Cape Fear River.</i>								
Fayetteville, N. C.....	100	38	15.4	2	4.8	30	9.0	10.6
<i>Congaree River.</i>								
Columbia, S. C.....	37	15	4.6	2	0.5	28, 29	2.4	4.1
<i>James River.</i>								
Lynchburg, Va.....	257	18	5.5	1	0.4	27, 28	1.4	5.1
<i>Alabama River.</i>								
Montgomery, Ala.....	265	35	6.4	5	0.5	31	2.2	5.9
<i>Cosa River.</i>								
Rome, Ga.....	225	20	6.0	1	1.0	30, 31	2.1	5.0
<i>Tombigbee River.</i>								
Columbus, Miss.....	285	33	— 0.1	6	— 2.9	28, 29	— 1.9	2.8
Demopolis, Ala.....	155	35	6.9	4	— 0.7	31	1.7	7.6
<i>Black Warrior River.</i>								
Tuscaloosa, Ala.....	90	38	7.7	1	0.5	29-31	1.7	7.2
<i>Savannah River.</i>								
Augusta, Ga.....	130	32	17.6	16	5.8	31	9.8	11.8
<i>Susquehanna River.</i>								
Harrisburg, Pa.....	70	17	4.2	14	1.3	29	2.7	2.9
<i>W. Br. of Susquehanna.</i>								
Williamsport, Pa.....	35	20	5.0	11	1.3	29	2.8	3.7
<i>Sacramento River.</i>								
Redbluff, Cal.....	241	23	20.6	15	3.6	1	8.1	17.0
Sacramento, Cal.....	70	28	17.6	31	13.6	12, 13	15.8	4.0
<i>Willamette River.</i>								
Albany, Oreg.....	99	20	18.0	15	5.2	26	9.2	12.8
Portland, Oreg.....	10	15	14.2	15	5.5	2	9.2	8.7

\* Distance to the Gulf of Mexico. † Frozen throughout the month. ‡ Frozen 5-16 and 21-31. † Frozen 3-8. ‡ Frozen 25-29.

## SPECIAL CONTRIBUTIONS.

## EQUIPMENT OF AN AERO-PHYSICAL OBSERVATORY.

By ALEXANDER McADIE, Local Forecast Official, San Francisco, Cal.

In response to a request by the Editor, Mr. McAdie has kindly allowed the WEATHER REVIEW to publish, in advance, the following extract from a paper submitted by him in 1894 to the Secretary of the Smithsonian Institution, in competition for the Hodgkin's Prizes. The use of the kite, the aero-plane, and the aero-motor, which has so greatly developed since that time, suggests, as Mr. McAdie states, a still further addition to the equipment. He also suggests that the magnetic outfit and the seismographic apparatus would be an appropriate addition, although rather outside of the direct line of atmospheric investigation. The list of instrumental equipment is as follows:

## EQUIPMENT OF AN AERO-PHYSICAL OBSERVATORY.

## BAROMETRY.

Standard barometers—Wild-Fuess, Fortin, Kew, United States Weather Bureau Standard.  
 Multiplying barographs—Richard, Marvin, Draper.  
 Aneroids—Redier or improved Hicks.  
 Statoscope for recording minute fluctuations of pressure, especially valuable during thunderstorms and gusts.  
 Sundell normal barometer.  
 Telebarometers, distant from each other not less than 1,000 feet in a horizontal direction and 500 feet in a vertical direction. This implies that the laboratory must be situated on the summit of a hill or mountain, with base stations. Buchan, in his résumé of the work done at Ben Nevis, intimates that some very important relations are thus discoverable.

## THERMOMETRY AND HYGROMETRY.

Standard types of thermometers—exposed, wet bulb, maximum and minimum, water and soil.  
 Thermographs and self-registering psychrometers.  
 Assmann aspiration psychrometer.  
 Telethermographs and telehygrographs.  
 Fog indicators.

## INSOLATION.

Actinometer (Schwolson).  
 Langley's bolometer, with appropriate galvanometers for the exploration and mapping of the solar spectrum, particularly the infra-red portion.  
 Photographic records of the more prominent absorption lines due to aqueous vapor in the atmosphere, and comparison, after proper scale determination, with the intensity of standard solar lines with the ultimate aim of ascertaining the distribution of vapor in the atmosphere at various altitudes and variations therefrom.  
 Spectroheliograph. A good 12 or 14 inch photographic objective for investigating the relations of solar spots, faculæ and prominences.

## NEPHOSCOPY AND PLUVIOMETRY.

Sunshine recorders of various types.  
 Nephoscopes and Pole star recorders.  
 Rain gauges and evaporimeters.

## ATMIDOMETRY.

Barus's device for showing colors of cloudy condensation.  
 Aitken's dust counter or coniscope.

The determination of the amount of haze or smoke present in the atmosphere is now quite neglected in meteorology, although a matter of very considerable importance to health. We should have daily records of the relative purity of the atmosphere.

## ANEMOMETRY.

Anemoscopes.  
 Anemo-cinematograph—an instrument showing the varying force exerted by the wind, preferable to the old form of anemograph; and yet some further improvement looking to a fuller recognition of what has been termed "the internal work of the wind" is desirable.  
 Helicoid anemometer.  
 Clinometer, or instrument for registering currents not horizontal.  
 Wind pressure gauge and suction anemometer.

## THERMODYNAMICS AND CHEMISTRY.

Apparatus might be devised which would give graphically the thermodynamic conditions of the atmosphere. The volume,